Testing Message Diffusion from Person to Person

BY STUART C. DODD

The origins, diffusion, and effects of rumor have long been challenging problems for the social scientist. The author here submits a progress report on a three-year study of rumor being conducted by the Washington Public Opinion Laboratory. Several pretests, as well as the project's working hypotheses, are described. This paper is a revised version of a paper presented to the Fifth Annual Conference of the American Association for Public Opinion Research at Princeton, New Jersey, in June, 1951.

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THIS paper is a progress report on a study of rumor. We are searching for principles of human interaction by studying rumor, or verbal diffusion of messages from person to person. We have simply chosen a form of interaction—namely, one-way mass oral communication—which can be treated with quantitative and controlled experimental techniques. As the research program is a large one, involving most of the Washington Public Opinion Laboratory staff for a three-year project, we are welcoming suggestions on its methodology while it is in the early stages. This paper outlines our plan of research, on which only the first few pretests have as yet been carried out.

OBJECTIVES OF THE RESEARCH

The objectives of Project Revere, as we call the research, are both practical and theoretical. It integrates a bit of applied and pure science in seeking principles of immediate use in operation, as well as principles of more basic value for social science.

Suppose that our Air Force wishes to drop leaflets on an enemy or a neutral population, whether civilian or military, or on our own population in a time of emergency when other means of mass communication have been disrupted. They want to know just how a message will diffuse through that population from person to person. How far will it spread? How fast will it spread? How fully through the population will it spread? How faultily? How functionally will it satisfy various psychological and social needs in that population? How effectively will the message be acted upon by the hearers? Some of the answers to such

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questions may be entirely dependent on the particular message, the particular population, and the particular situation. But some generalizations may be induced about these diffusion factors: the number of retellers and the accuracy, speed, and distances of telling the message. (These are the basic factors or dimensions of diffusion: the *actors acting in time* and *space*.) What can we generalize about this one-way verbal interaction or chain communicating? Answers to questions such as these, under varying but specifiable conditions, serve both the practical and the theoretical objectives of the project.

DESCRIPTION OF THE PRETESTS

To answer these questions, experimental designs are being developed. Examples of a half-dozen of these pretests will be described here briefly.

One pretest (Pretest B) was made on the campus of the University of Washington, using civil defense as motivation for spreading a message. The message was a letter from the President of the University and the Civil Defense Office giving instructions about alerts or atom bomb raids. At the end of the 10 o'clock class one morning, each of 500 students in the "starter sample" received this letter with six "alert cards" and the request to pass five of them on to their friends. They were also asked to show their cards to other friends, and to tell them where more cards could be secured. They were also given a postcard they could mail in to the office, volunteering their time for Red Cross work (if needed) in a list of specified jobs for which they could indicate their experience and preference. The tactile, visual, and auditory forms of person-to-person diffusion were checked on by polls after two-, four-, and seven-day intervals on different samples of 500 students each in the student body of 14,000. These successive polls were intended to test the speed of diffusion, the distances and places of diffusion, and various other conditions correlated with diffusion.

A questionnaire, given before the stimulus letter from the President was received, got some indices of fears or tensions about the atom bomb. Among the hypotheses, it was expected that students showing the most fear or tension would tend to do some tension-easing act, such as mailing in the postcards, in larger proportions than students with less tension. Another feature of this study was the use of before-and-after polls of attitudes, getting the attitudes of the starters before the

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stimulus was given to them and again after the week's participation in distributing the message. This pretest developed the techniques for more exact trials planned in other universities.

The analysis of data suggests generalizations such as the following for checking in other studies:

1. Tactile distribution went most rapidly, being half completed within two hours, while visual communication went more slowly. The auditory communication was slowest of all to develop under the conditions of this pretest.

2. Two different kinds of motivation, one designed to appeal to self-preservation and the other to group-preservation or group organization, with a control of no appeal, were tried out in different paragraphs of the President's letter. No significant differences were found.

3. The growth curve for the tactile, visual, and auditory diffusions were die-away or decelerating curves, being most rapid at first and running rapidly toward completion within the week.

4. The rumor waned with what we call "use distance." It spread most rapidly in classroom buildings, less rapidly elsewhere on the campus and in eating places, still less rapidly in other places off the campus but in town, and not at all outside the town. A scale is being made up from this ordinal set of weighted zones, or centers of interaction, so as to predict a smooth curve (which the weightings can make an hyperbola) to be tested on other university populations.

5. The contingency coefficients among the various attitudes of tension and relevant later behavior are mostly low, running less than .5. Some of the attitudes, however, run up to coefficients of .9 (as, for example, wanting more Civil Defense on the campus and in the city).

The next two pretests which were made used money as motivation and were run, for comparison, in a village of 190 people and in a city housing project comprising 36 families. A dollar bill was offered to anyone who reported having heard the offer, provided he tagged each telling of the rumor by noting on a slip of paper the teller's name and the time and place of telling. Any hearer with such a tag could collect a dollar at a designated center. In the housing project, this was followed with a census of every household to find out who had heard and not acted, who had not heard, and the characteristics of the different groups. The housing project yielded a hearers-per-teller ratio of less than unity, indicating a rapidly dying rumor.

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In the village, the experiment was a dud, as no one called in during the next five hours. We suspect that the execution of this experimental design was spoiled by too short an incubating period (waiting for the hearers to come in at the center). It was also marred by an awkward center (a car parked in front of the library) which probably deterred people from inquiring. Chiefly, we learned that inadequacy in any one or more of the many variables involved in such a pretest can wreck the entire experiment. Artificial launching of a rumor seems to be a product of many factors. This product is reduced to zero if any essential factor is absent. Hence we treat the situation as a mathematical product of factors rather than as the usual sum of variables (as in computing a multiple correlation, for example).

Pretest C_3 used commercial motivation in a familiar type of advertising campaign. The site was a small town of 900 inhabitants. The town was carefully selected to hold a dozen ecological variables fairly constant so as to isolate the rumor diffusion variable and conform to the assumptions of a homogeneous population that were involved in the mathematical models used by the hypotheses. Our interviewers called at every fifth house and told of a new slogan for a coffee company. They promised one pound of free coffee to anybody in the town who knew the slogan when the interviewers called at every house a few days later. The next day a civilian plane dropped 30,000 leaflets over the town. These were intended to stir curiosity by announcing that one person in five in the community had been told the new slogan and that anyone who wanted a free pound of coffee could find out the slogan from those who knew it. On the third day interviewers took a census of households and delivered the coffee (provided by the coffee people at no cost to the project) to those who knew the six word slogan. The questionnaire investigated the factors of the hearers, the tellers, the time, the place, and other conditions for the diffusion of the coffee message and the news of the leaflet drop.

In Pretest D a metropolitan city was used, with civil defense motivation. An Air Force plane dropped leaflets in nine drops, seven by day and two by night, to test visibility conditions; the drops varied from 1000 to 5000 feet in order to test the patterns on the ground from different altitudes of burst of the leaflet package. Finders were asked on the leaflets to mail one of them in after filling out the questions as to where and when it was found, and whether it had been picked up

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from the ground or received from another person. The appeal was signed by the Governor of the State and the request was to help make a civil defense test in the interest of national defense. Out of some 50,000 leaflets dropped, almost 4000 were mailed in from an area containing some 8000 households. The Air Force made careful instrumental checks of the physical factors, including aerial photographs before, after, and during the drop. We made samplings of the density of leaflets on the ground to map the areas exactly.

In addition to the mail-in leaflet questionnaire, five other techniques were tried out to observe the public's response to the mass stimulation. These included watchers, inquiries from the public, a door-to-door poll, a telephone poll, and a newspaper poll. We stationed watchers at street intersections in a grid pattern to observe the population's reactions. The daytime air turbulence below 500 feet marred the delivery of leaflets in the target areas and reduced the watchers' effectiveness, however.

Spontaneous telephone calls of inquiry were reported on forms given to the telephone clerks of the chief agencies from which the public might inquire. Only seven calls were received. The leaflets were apparently so explicit that no anxieties or uncertainties were aroused in people's minds. Then, by areal sampling, a small, intensive, door-to-door poll—and in another area, a telephone poll—checked on the population in the "drop area." Data were collected from those who heard or saw nothing, from those who heard or saw but did not act, and from those who mailed in cards as requested.

A fifth technique of observing the public response to the mass stimulation by leaflet was a newspaper questionnaire, which was to be clipped out and mailed in from all over the metropolitan area. The reader was asked to report whether he had seen or heard of the leaflets, and at what time. As this questionnaire was not placed in an easily clipped position, such as the lower right corner of the front page, and did not have sufficiently clear and strong instructions, only a few were returned. In sum, three observation techniques worked out well, while three were ineffective for reasons that can be controlled in further testing. The substantive findings are still incomplete and are not included in this progress report, which chiefly describes methodology.

A further Pretest E, now in the planning stage, will use "bait" in high schools. This "bait" will be offered to students who call in at a

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center for it and report how they heard that it was being offered. Other experiments may involve contests, lotteries, juicy local news, emergency situations when available, readiness to move into any type of disaster area which might occur, and studies in any war zones in the future.

ANALYSIS OF THE PRETESTS

We have analyzed the process of message diffusion into four main stages yielding four classes of variables: the physical, the psychological, the social, and the semantic. Project Revere concentrates on the social variables. The interacting of people is its chief concern, but it must also deal with the other classes. Lists of variables are being compiled. For example, we have listed 50 physical variables affecting the drop between the plane and the ground. These are broadly classified as factors in the plane's crew, in the plane, in the leaflet container, in the leaflets, in the weather conditions, or in the terrain. The results of drops will be systematically recorded in loose leaf style as tables, eventually building up norms from experience and developing standard operating procedures for each variable.

The listed variables are being subclassified into four classes according to our current degree of control over them. The first class, with most control, are the variables which are experimentally varied in order to study their effects. The two altitudes of leaflet bomb bursts in Pretest D; and the two motivations appealing to self-preservation and in-group preservation in Pretest B are examples of experimentally varied variables.

The second class are the variables which are experimentally constant at one value during one test. Examples are the number of leaflets, their color, format, and message, or the size and characteristics of the population in the community we select to stimulate.

The third class of variables are those which are statistically controlled by measuring them as they may vary. The wind velocity, the hearers-per-teller potency of the rumor, the tellings-per-period speed of the rumor are examples of the statistically controllable variables.

The fourth class are the uncontrolled variables which we can identify but have not yet measured in our tests. Examples are the interest (before trial) of a message to a given population in a given situation, or the prestige its teller thinks he gets. These uncontrolled variables challenge the researcher to conquer them.

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A number of exploratory tests using different motivations, different situations, and different locations in the State of Washington, are planned as pilot studies during the first year of the project. The second year will see more definitive testing of the hypotheses and checking of the most important findings in other situations in the United States. In the third year, it is planned to check the most important findings in other countries in order to weed out what is most local and temporary and to establish findings of greater generality. In testing principles of human interaction, we keep in mind the following five desiderata: (1) the principles should be universal to different cultures, (2) in different geographic areas of the world, (3) and as permanent in time, (4) as important to the respondents, and (5) as inclusive of a wide range of cultural interest as possible. In short, our criteria for selecting hypotheses and other conditions are to try to maximize the basic dimensions of time and space, of population and culture, and of worth of the message to the respondents.

The hardest part of our problem seems to be to launch, under normal conditions, ethically-permitted rumors that will spread dependably. Rumors are capricious things. They flourish under conditions of high tension and in the absence of authoritative, trusted, and available information. Under normal peacetime conditions, where our mass media are adequate and trusted and the unusual is unlikely to happen, rumors just don't spread far enough to yield a statistically observable result. Consequently, we are trying a wide range of schemes to find how a rumor can be started-to-order under normal peacetime conditions and used as a vehicle for experimentation. We are, of course, under the further limitation that our rumors must be true and ethical ones and openly done; the black propaganda of wartime is not available to us. Perhaps the largest carry-over from our peacetime experiments to possible war situations will be the development of techniques for measuring and controlling rumors.

Toward measuring the public's response to the messages we launch as mass stimuli, we are using four major techniques. The first is polling, by home interviews, telephone calls, or mailed questionnaires. Here we have either a sample or a census of a whole community, polled in any complete experiment before, during, and after the diffusion so as to measure its temporal course. The earlier polls are being designed to yield predictor variables of diffusion and of acting-as-told.

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A second technique is the acting-as-told technique. Here we count the mail-ins which our message has stimulated, or the call-ins, or the personal come-ins to a center. The purpose of this is to measure the actions of the population in doing what the message has told them to do, and what many people may do (or do often), thus providing a large enough statistical population for probability principles to work out smoothly and yield reliable observations.

A third technique is the use of watchers. When the air drop is used, we station observers watching and photographing the leaflets as they fall, and observing the public reaction. The watchers count the number of people in the area, the number who pick up leaflets, the number who leave them, the number who throw them away or pocket them, and the number who respond in various ways to the questioning on the spot. Watchers also mingle in key groups, in shops, work places, or institutions where the spreading of the message can be noted by participant observers from group conversations.

A fourth technique uses tags. Here the message is reinforced by the tactile channel of a teller handing a slip of paper to the hearer, recording their two names, the place, date, and perhaps other conditions. The tagging techniques may be either open or closed. In the open style, anyone may tell as many people as he likes, giving each a slip of paper with his name and the place and time of telling, and the hearer may use that slip as a receipt for some commercial reward given out at some center. This "bait" may be a dollar bill (which is cheaper than an interview for the experimenter). In cooperation with some commercial firm, the "bait" may be some advertised product.

In the closed form of tagging, all the variables are rigidly controlled, but at the cost of an artificial impediment on the free transmission of the rumor. Here, pads of printed slips with space for recording the person, time, and place of each interact are distributed to starters. Each starter's pad has a cover sheet which he fills out and can turn in for his bait, and the rest of the pad breaks into a dozen sub-pads which he may give out to anyone he wishes. Each sub-pad has a similar cover sheet entitling the receiver to the bait when it is filled out. It too breaks into a dozen sub-pads to be passed on if desired. This may continue for three or four removes, as the experimenter chooses. This controls the maximum hearers-per-teller ratio. It can control the time of telling if each pad is good only within certain time limits. It may also

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control the distances by carrying restrictions in the instructions. When the pads are printed on thin paper, starters may get a three by five inch pad two inches thick, which may go to a geometric series of recipients summing to over a thousand persons. The attempt of this self-recording or tagging technique is to get detailed evidence free of memory error. This evidence carries a double check, as every interact will be recorded both by the hearer and the teller, and the reliability of all records is greatly increased. The printed slips also act as reminders restimulating their possesser to pass them on. Sociometric data about who tells whom, through what channels and under what conditions, can be recorded with great precision.

It is a further problem, then, to see whether the findings of such controlled handbill diffusion agree with the findings from freer, more spontaneous word-of-mouth rumors.

HYPOTHESES FOR THE THEORETICAL OBJECTIVES

The foregoing description of the practical and methodological aspects of Project Revere would give a one-sided picture if it were not filled out by the more theoretical aspects of the project. These consist in research for laws under specifiable but highly general conditions. These candidate laws are stated as hypotheses which always relate two or more variables together in some specified way and under specified conditions.

Desirable Features. These hypotheses should have the following features as far as they can be achieved with our current knowledge and resources:

1. They should be empirically testable. Only hypotheses which can be accepted or rejected from experimental tests within our resources are proposed.

2. Hypotheses should be reliable on repetition. This means there should be high agreement on re-observation under varying conditions, such as varying the samples (re-sampling reliability), or varying the occasion (re-test reliability), or varying the interviewers (re-interviewer reliability), or varying the phrasing of the questionnaire (re-phrasing reliability), or varying other conditions for other forms of reliability.

3. The hypotheses should be highly general, holding under a wide range of situations or cultures.

4. The hypotheses should supply rational explanations. They should

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go beyond the mere empirical description that is given by a fitted curve. They should imply some social mechanism corresponding to the mathematical assumptions or properties of the model according to which a given curve or model is to be expected in advance of observation. In other words, they should propose models which are plausible *a priori*. Thus our logistic hypothesis can be shown to approximate the most probable form of growth of an attribute, given a limited homogeneous population acting steadily. Similarly, our harmonic hypothesis can be shown mathematically to be the necessary consequence of a message diffusing from one spot through a homogeneous population, if it grows only via neighbors (i.e., at the circumference of an expanding circle).

5. The hypotheses should be candidates for scientific laws in sociology. To the extent that they have sufficient import and generality to be candidates for such scientific laws, they will justify the expense and effort of the experimentation.

Tests of Hypotheses. Hypotheses are tested primarily by the size and secondarily by the reliability of indices of agreement between the observed and the expected data. These indices of agreement may be correlation coefficients, or contingency coefficients, or other appropriate measures of degree of relation. For interpretability, "agreement" indices that run from zero to unity at maximum are preferred in comparing the acceptability of different hypotheses from different situations. Then the probability indices, such as a 1 per cent confidence level, measure the reliability or statistical significance of the index of agreement. To test an hypothesis both kinds of indices are needed; neither alone is adequate. We need to know how closely the hypothesis expectation agreed with the observed data, and the probability of that degree of agreement recurring in many similar samples.

The pretests are used to generate hypotheses and to explore them. Then more definitive tests are made in further situations on other data. For these tests, one may pre-assign critical amounts of agreement of each index for acceptance or rejection of an hypothesis at a given level of validity and reliability.

Examples of Hypotheses.[1] Four examples of the dozen or more hypotheses which are being explored so far will be outlined here. A

[1] Full descriptions of these hypotheses and of three of the pretests described above can be had on request to the Washington Public Opinion Laboratory.

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simple hypothesis with a good deal of evidence already accumulated for it is the harmonic hypothesis. This expects that diffusion will vary inversely with the distance the rumor has traveled. It is a case of what mathematicians call the equilateral hyperbola. It is also known as the rank-size rule, which Zipf has studied. It means that the rumor fades with the distance. In generalized form, the equation is: $I = kL^{-a}$.

The coefficient, k, and the exponent, a, may be solved for by curve fitting techniques. In some 30 such fits on diverse data that we have made to date, the exponent has a central tendency of unity, so that we expect the interacting or diffusion to decrease as the first power of the distance it has traveled. This can be shown to hold mathematically in a homogeneous space, regardless of whether the rumor travels along a line, or in a plane, or in a cubic volume (as in an apartment house of many floors). The assumptions are that (a) the population is homogeneous, (b) it is evenly distributed, and (c) the message starts in one point and travels via neighbors. This means that the harmonic series (i.e., the reciprocals of the natural numbers) is expected to fit well any population whose members have like traits, like spacing, and who re-tell those nearby. More complicated models may vary these three mechanism variables of homogeneity, density and contiguity. Thus the data may lack homogeneity, as in sectioning the population by cliques or barriers or other overlaying variables which make for differential ratios of spatial diffusion. Or the data may lack uniform density, as in crossing both urban and rural districts. Or, again, the data may lack contiguity, as when people re-tell the message in jumps across distance by phone, letter, radio, etc.

A second set of hypotheses relates diffusion to the time factor in a growth curve. Diffusion may be very simply defined in all-or-none fashion, as by the number of persons who have heard the rumor up to a given moment. It may be measured in a more refined form allowing for degrees of diffusion, as in a score for the faultlessness of telling the rumor. Other refinements may involve the number of times the rumor has to be heard (or the conditions under which it has to be heard, or the persons who have to tell it) in order to be believed.[2]

We expect that the message will usually grow in time in an S-

[2] For a well worked out set of mathematical models showing the consequences of varying assumptions, see: Winthrop, Henry, "Kinetic Theory of Socio-Psychological Diffusion," *Journal of Social Psychology*, vol. 22 (1945), pp. 31-60.

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shaped curve, starting slowly, then speeding up as more and more tellers are at work, and finally slowing down when there are only a few hard-to-reach people who have not heard it. Such an S-shaped curve might be a logistic, a normal, a Gompertz or other curve. We choose the "best" curve partly on empirical grounds of closest and best fit and partly on rational grounds.

Our chief rational criteria are to prefer the curve or model with both the simplest assumptions and the ones which correspond most closely with the social conditions. Thus the logistic curve can be shown to be the most probable growth curve in a homogeneous population where the conditions are that everyone has an equal chance of interacting with everyone else. To show this, let a sociometric matrix be made up, listing every person in the population as head of a row and again as head of a column and entering in each cell a one or a zero according to whether the row person has or has not told the rumor to the column person. Next, let the matrix be sectioned each way into a proportion, p, who have heard the rumor up to a given moment, and a complementary proportion, q, who have not heard it (where $p+q=1$). Then the interacting of the whole population may be mathematically represented by the product of multiplying all possible interactors by each other. Thus $p+q$ gives the product of p^2+pq+q^2. p^2 represents the proportion of the whole population who are knowers talking with knowers—which does not increase the number of knowers. The q^2 represents the non-knowers talking with non-knowers—which does not increase the knowers. The $2pq$ represents the two sections of the matrix in which knowers talk with non-knowers—which is where the knowers increase in number. pq, then, represents the probable increment in knowers in a unit of average time of interacting. If these pq increments in successive unit periods of time are added up, their integral is the logistic S-curve. We study the logistic curve, therefore, as an excellent example of an empirical and rational hypothesis—one that corresponds both to the data and to an *a priori* and plausible mechanism.[3]

[3] This logistic curve is definable by: $p_t = \frac{p_0}{p_0 + q_0 e^{-kt}}$ where p_t = the proportions of knowers up to time, t, p_0 is the proportion of starters and e is the natural log base, 2.718, and k is a sort of average hearers-per-teller-per-period ratio or "potency index." $k/4$ is the tangent at the midpoint which is also at the middate and is at the point of inflection of the curve.

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In this logistic equation, the chief parameter (k in the exponent) may be observed and predicted. It represents the general slope of the curve, being steep for a rumor of high interest to the population and of lesser slope for rumors of less interest. It is an average hearers-per-teller ratio. Once it is known from a trial sample or from a curve fit, the whole logistic might be plotted or even forecast ahead of time (provided either the unit or total time and the available population are also known).

With this logistic curve as a base line to expect in a strictly homogeneous population, deviations from it can then be measured by the extent to which overlaying factors make the population unhomogeneous in the many specific ways one finds in practice. This logistic curve is not at all the only way of describing with good fit the growth of rumors. We will try fitting many different kinds of curves. But we expect, on rational grounds, that since the logistic curve is the most probable one it will be the most frequent one in proportion to the conditions' approach to perfect homogeneity (or such great diversity as to approximate this probabilistic structure).

The Fechner hypothesis applies the Weber-Fechner principle of sensory psychology to the realm of attitudes. It relates the stimulus (V) to the response (D), or goals to the striving, in a log curve, or, more generally, in a power series.[4] This hypothesis expects that equal increments in response of one kind observed in many instances will tend to vary with a power of the number of units of stimulation. This expectation must be carefully qualified as to the units in which it is computed and as to the zero point from which it starts. It is expected to hold only between the indifference and satiety points on the positive side or between similar points on the negative side, representing approaching or withdrawing behavior respectively. The familiar U curve in opinion polls relating the intensity of opinion to the content of an opinion (around a neutral point or nadir of intensity) is a familiar example of this tendency to a logarithmic relationship in the Fechner hypothesis.

A fourth example of our hypotheses in Project Revere is a sum-

[4] This power series is defined by Guilford's equation (Guilford, J. P., *Psychometric Methods*, New York: McGraw-Hill, 1936, p. 139): $\Delta D = kV^v$
where D = an increment in the intensity of desiring, indicated by striving, etc.
V = amount of a desideratum, or object of value
k = a constant

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marizing one which relates all the chief variables together in a general way. It is our dimensional hypothesis relating the seven diffusion variables together as a product of powers of basic factors, which is the definition of a dimensional formula throughout physics and in our dimensional analysis in sociology. To understand this formula, it is first necessary to point out the seven factors which we take as basic classes of variables, whose mathematical product is the diffusion (or human interaction, more generally).

The formula for a rumor, or for human interacting generally, may be expressed in seven paraphrases of seven factors each, as is shown in Table 1. The first paraphrase is in the interrogative form; the second is in the sociological form; the third is expressed in operational language; the fourth uses simple folk terms for the rumor case of interacting; the fifth is expressed in statistical indices; the sixth uses psychological language; and the seventh is an algebraic formulation.

TABLE 1

1	2	3	4	5	6	7
Who?	does what?	because of whom?	why?	how?	when?	where?
Controllees	responding to	controllers'	stimulation	in specified ways	at specified times	and places
One person	reacting in unit amount to	one person	with unit stimulus to act	by unit means	in unit time	across unit distance
Hearers	re-tell what	tellers	told	somehow	sometime	somewhere
A number of hearers	doing some number of acts	because of a number of tellers	and a number of their acts	under some amount of each condition	in a period	involving distances or areas
Reactors	reacting	to actors'	acting	somehow	sometime	somewhere
$I_{pp} = P_B$	I_B	P_A	I_A	I_c	T	L *

* In the more exact dimensional form, where the exponents are explicitly written, the formula is as follows: $(I_{pp}) = (P_B)^p (I_B)^i (P_A)^p (I_A)^i (I_c)^i (T)^t (L)^1$

Where I= the interacts; I_B = the reaction, a re-telling; P_B = the population of hearers here (or reactors in general); P_A = the population of tellers here (or actors in general); I_A = the stimulus-action, a telling; I_c = indices of conditions; T = time; L = distance. This dimensional formula, as in all dimensional formulas, ignores the absolute size of units (and ignores origin points) in asserting a constant relationship between the variables—namely, a product of factors each weighted by its exponent. If the exponent is positive, the factor increases the interaction; if

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The most important point about this dimensional hypothesis is that the variables are combined by multiplication, not by addition. The interaction is stated as a mathematical product of factors, not a sum of addends. The dimensional hypothesis expects that this product of factors will fit the data better than any of the same variables treated as a sum. For multiplication is the symbolic way of representing joint or simultaneous factors in a gestalt or unified situation, where addition mathematically represents alternative factors in a set of data not necessarily unified. The crucial test of whether data should be combined by addition or by multiplication is whether the non-existence of any variable—that is, its taking on a zero value—has the effect of making the whole product vanish. If it does not, then they may be additively combined. If one factor being wholly absent washes out the result, then multiplicative combination is indicated. Thus, if there is no teller, there can be no interaction. If there is no hearer, there can be no interact. If there is no act, nor any manner of doing it, there is no interact. If there is no time involved whatever, there can thus be no interact involved in finite time. If there is no distance involved, even that from teller's lips to hearer's ears, there is no interact. Each of the factors is thus found to be an essential one to make a logical product. This is a test that shows that the factors of interaction are component parts of it, and other variables that we call the conditions of interactions are simply correlated variables.

We believe this formula for human interaction to be entirely general to any kind of interacting of people. It seems a candidate law for the amount of human interaction. It has also been called the principle of demographic gravitation, for it happens that the form of the formula parallels that for physical gravity. In fact, the two can be considered as special cases of one more general formula for interaction of any sorts of particles in space and time. If the particles are molecules, clustered

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the exponent is negative, the factor (as in the case of distance) decreases the interaction; while if the exponent is zero, the factor *qualifies* the interaction without changing its quantity (since any factor-to-the-zero-power is unity, $X^0 = 1$). Non-zero exponents assert a quantity, an algebraic variable. Zero exponents assert a quality, a class in symbolic logic. Thus:

$(I_{pp})^0 = (P_B)^0 (I_B)^0 (P_A)^0 (I_A)^0 (I_c)^0 (T)^0 (L)^0$ asserts that interaction is a logical product of seven classes, namely, actors and reactors, their actions and reactions, their manner, duration and distance apart.

To make a dimensional formula become a statistical formula requires specifying the index with its units and origin for measuring each dimension.

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in physical masses, the formula becomes that for physical energy of gravity. If the particles are persons clustered in human groups, the formula becomes the formula for human interactance. If the particles are dice or probability elements the formula becomes that of the mathematical law of joint probabilities.[6] Thus, this dimensional hypothesis can be tested in the particular situation of rumor diffusion and can contribute a bit toward testing what may become one of the most important laws of social science; namely, the principle predicting the amount of interacting of any one kind to be expected between groups of people under the simplest condition of equal probability of interacting.[7]

The four examples of hypotheses above involve mathematical models or formulas at a high level of generality and abstraction. These are cited as of possible interest to a wider range of social scientists than more specific hypotheses. There will be a large number of more specific hypotheses formulated and tried out to explore many other conditions for rumors. At first we do not limit the inquiry to models nor to formal hypotheses, but ask: What can we learn about message diffusion from person to person? A large mass of notes, concepts, variables, relations, assertions, designs, etc., are being gathered or invented; from these testable relations increasingly emerge.[8]

[6] The distance factor complicates these by involving the formula for circumferences and areas of circles.

[7] For fuller discussion of this interactance hypothesis see: S. C. Dodd, "The Interactance Hypothesis—a gravity model fitting physical masses and human groups," *American Sociological Review*, Vol. 15, No. 2 (April, 1950).

For fuller discussion of dimensional formulas in the social sciences see: S. C. Dodd, *Dimensions of Society*, New York: Macmillan, 1942, p. 944, and S. C. Dodd, *Systematic Social Science*, Seattle: University Bookstore, 1947, p. 786.

[8] A full bibliography on rumor diffusion has been systematically gathered. Abstracts of it in mimeographed form can be supplied by the Laboratory upon request.

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